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OCT 30 1998

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Mr. Daniel B. Phythyon
Chief, Wireless Telecommunications Bureau
Federal Communications Commission
2025 M Street
Room 5002
Washington, DC 20554

Re: Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems, CC Docket No. 94-102, RM-8143

Dear Chief Phythyon,

Nokia Inc. ("Nokia") is hereby responding to the Bureau's request for information contained in the Order released September 30, 1998 in the above-captioned proceeding.[1] Specifically, the Bureau invited industry groups and companies who have participated in the ongoing TTY Forum to respond to specific questions regarding the work being undertaken by individual wireless equipment manufacturers and carriers to comply with the Commission's Rules regarding compatibility of their equipment and services with TTY devices.[2] As a charter member of the TTY Forum, Nokia is pleased to offer the responses contained herein to certain of the Bureau's specific questions.[3]

[1] Revision of the Commission's Rules to Ensure Compatibility With Enhanced 911 Emergency Calling Systems, CC Docket No. 94-102 (rel. Sept. 30, 1998) ("Order").
[2] Id. ¶ 10.
[3] Nokia offers comment only on those questions that relate specifically to its expertise as a wireless manufacturer and its efforts

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I. INTRODUCTION

Nokia is a leading manufacturer of telecommunications equipment in the world and in the United States. Nokia is the world's leading developer of digital handsets and the largest manufacturer of mobile phones. Throughout its history, Nokia has been an industry leader in developing products accessible to a wide variety of consumers. As part of its commitment to ensure that its products are accessible to the widest number of consumers, Nokia has been involved in the TTY Forum from its inception. Through its involvement with the TTY Forum, Nokia has worked with the FCC, consumer groups representing individuals who are deaf or hard-of-hearing, TTY manufacturers and representatives of the wireless industry to develop a solution for transmitting TTY calls on digital wireless systems. As noted by the Commission, however, the TTY Forum has not yet been able to develop solutions that will enable TTY users to make 911 calls on digital networks.[4]

II. RESPONSES TO THE BUREAU'S SPECIFIC QUESTIONS

Question # 3: For each of the digital technologies (i.e., TDMA, CDMA, GSM, and iDEN), have manufacturers been able to determine the root technical causes for the incompatibility between TTY devices and their systems? If so, what is the nature of these root technical causes, for each technology?

Nokia has been concentrating on finding the root technical causes of the problem. Numerous field tests have been conducted by various manufacturers, including

[4] Id. ¶ 4.

Nokia, without conclusive results. Field test data lacks repeatability and accuracy. Nokia is currently testing all technologies under uniform field conditions to be able to quantitatively describe the various root effects. During the last TTY Forum-8, Nokia presented test data from its laboratory testing of TDMA and AMPS technology. A copy of this data is attached hereto as Attachment 1. The data presented showed both repeatability and accuracy and provided useful insights into the root causes. Nokia is currently conducting further laboratory tests that will allow us to limit the number of degrees of freedom in every test and enable us to determine cause-effect more conclusively.

The data shown in Attachment 1 allows us to divide the character error rate ("CER") versus the received signal power plot into two regions: Vocoder limited and link noise limited. When the link conditions are favorable, the CER is only attributed to Vocoder distortions (CER ranged between 2 to 6%). As the link conditions worsen, the CER increases exponentially at around the phone sensitivity level (approximately -113 dBm). It must be kept in mind that laboratory measurements represent the best possible case, while actual field conditions may be much worse. Nokia is in the process of testing handsets of all technologies under all known simulated field conditions in the laboratory.

Concerning the technical root causes as a function of technology, it is our experience that the fundamental causes are the same for all technologies. While one technology may be more sensitive to a certain parameter than another technology, all technologies are affected in various degrees by most parameters. The primary root causes for incompatibility are: Vocoder distortion, received signal level, multi-path fading effects, receiver attack time, hand offs, adjacent and co-channel interference, various network effects, and TTYs' performance. Field measurements performed by Philips indicated that low CER was observed when two similar TTYs (same

manufacturer) were communicating. Similarly, the CER can be very high if the two TTYs were different (different manufacturers). The reason for this discrepancy is the fact that TTYs have a built-in strategy to handle unexpected situations, such as missing the start bit or encountering an unexpected silence period. This strategy is generally not very critical when TTYs are connected to landline, since the link is robust. However, under the more technically challenging conditions presented by a wireless environment, these strategies can be extremely important. TTYs do not have a standard method of handling errors. This is due in part to the lack of a mandatory standard.

Question # 4: What potential solutions have been submitted to appropriate standard-setting bodies or forums for their review and analysis?

Nokia has discussed the following options: V.18, IS-707, IS-130, IS-135, and GSM-NA standards. In addition, CTIA has been contacting modem manufacturers to encourage them to develop V.18 modems. The development of other potential solutions has been slowed because the TTY Forum has been concentrating all of its efforts on addressing a short-term voice channel solution. This has prevented participants from dedicating sufficient time to the development of a data solution. Currently, potential data solutions have not matured enough in the standards process to provided a near-term solution. The only standard that has been discussed in sufficient depth was IS-707, which represents the CDMA protocols. However, the IS-707 standard has not been implemented.

Nokia has been working with a third party vendor in developing a data solution whereby its Communicator 9000 may be used as a TTY device, providing TTY users with the benefits of a digital phone and the additional functionalities of the

Communicator. This solution wuld allow TTY users to communicate with TTY devices employing a baudot signal. Nokia demonstrated this service to several FCC staff and CTIA personnel recently and will be providing additional demonstrations to FCC staff on November 3 and to the TTY Forum on November 4.

Question # 5: Are there any segments of the wireless industry that might be crucial to the development of the potential solutions that are not represented in the Forum, e.g., manufacturers of Inter-Working Functions (IWF), who would have to modify IWF software as part of a data solution) and is their representation necessary for implementation of such solutions?

There might be a lack of expertise for the IWF side in the TTY Forum due to the Forum concentration on short-term solutions. As noted, Nokia has already attempted to utilize an IWF to make the Communicator 9000 compatible with TTYs. Nokia, along with the third party vendor with whom it is developing this product, will be presenting a demonstration of this capability at the TTY Forum on November 4, 1998 in Baltimore, Maryland.

Question # 6: Explain the possible negative consequences of any potential solutions for TTY users, e.g., the reduction in throughput that would result from the insertion of additional bits between transmitted characters.

Our experience with reducing throughput showed improvement in character error rates only at high received signal power. When the received signal power is low (near receiver sensitivity levels), reducing throughput caused the character error rate to

go up. This is due to the fact that the receiver, when faced with silent periods (which occur when reduced rates are used), will need time to re-acquire the signal. For AMPS, this time delay is caused by the expander attack time, and it is about 30 milliseconds, causing the receiver to completely miss the start bit (start bit is 22 milliseconds). Similar phenomena happens with digital phones because the vocoder needs several frames before reaching steady state. For full rate transmission however, the absence of silent periods will cause a single character error to propagate causing several character errors. The silent periods help to re-align the receiver and prevent errors propagation.

The consumer groups showed lack of interest in any solution that causes rate reduction, especially on the landline side. Nokia does not see a clear benefit of reduced rates. Further testing is in progress currently to verify our understanding of this issue. Nokia's preliminary test data indicates that a reduction in throughput will not be an acceptable solution for all technologies and that the resultant data rate is too slow to provide a viable solution.

Question # 7: For each of the digital technologies, what would be the timetable for implementation of a data solution on an equitable basis with voice services offered?

The modem industry has speculated that it will be 18 months before an actual "physical" V.18 modem exists to support digital input to TTY protocol conversions.

Question # 8: If an extension were granted in order to reach a long-term solution to the problem of incompatibility between TTY devices and various digital systems, what could each carrier do in the interim to accommodate TTY users on wireless systems?

One possible interim solution is a functionality in dual mode handsets that would provide the handset the ability to recognize that it is connected to a TTY device. Once the TTY device is connected to the handset, it would lock onto the available analog signal, allowing the user to place TTY calls over the handset. This solution would allow TTY users to enjoy many of the fuctionalities of digital phones such as caller ID and short text messaging while allowing them to place TTY calls with acceptable character error rates. Nokia is supporting various service providers in developing such an interim solution.

Question # 10: Will field tests be conducted, including tests involving actual TTY users, following completion of the laboratory tests?

Yes, we are planning to perform field tests to provide an end user verification of all the laboratory tests. While field testing does not provide quantitative description of the performance, it can provide a realistic measure of whether various solutions actually work in practice.

Question # 11: Have carriers provided equipment and wireless service to TTY users so that users can conduct their own field tests? If equipment and service have not been provided, what obstacles have prevented carriers from doing so? What are the carriers' plans for providing equipment and service to facilitate future field tests by TTY users?

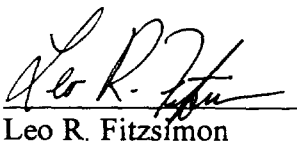
Nokia has provided handsets to Gallaudet University for testing and is providing handsets to the National Association for the Deaf for testing. Nokia will

continue to work with Gallaudet and consumer groups representing individuals who are deaf or hard-of-hearing to conduct field tests of equipment.

III. CONCLUSION

Nokia has been pleased to be a part of the TTY Forum and will continue to work with all stakeholders to develop workable solutions to benefit all of its customers. Please contact the undersigned if you have any questions.

Respectfully submitted,



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ATTACHMENT 1

TTY-Wireless Phones Laboratory Tests

Mohamed El-Rayes

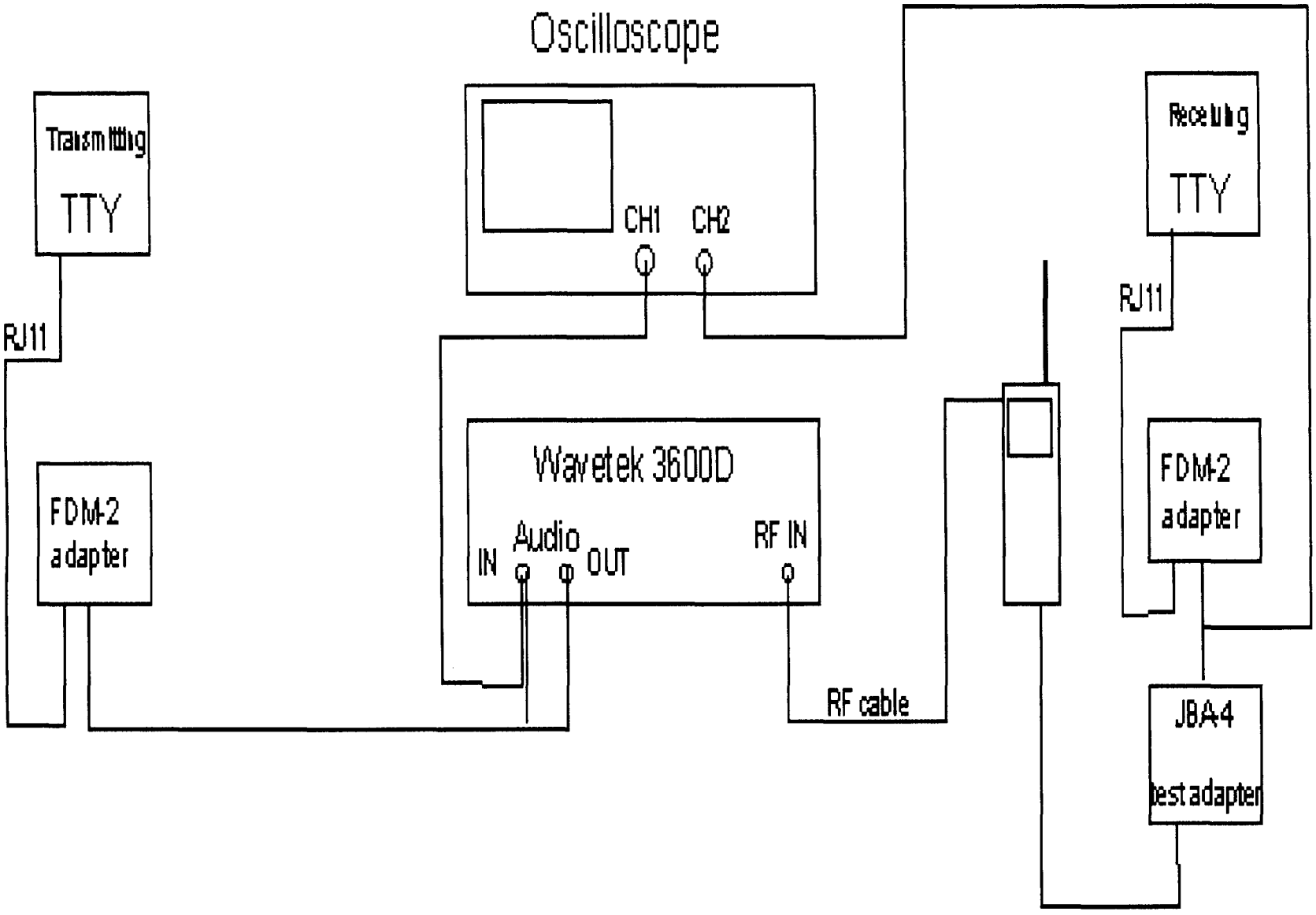
NOKIA INC.

8 October, 1998

Approach

- Test in the lab to isolate and identify sources of errors
- Using basestation simulator as shown in the set-up
- Ultratec TTY on both ends (Tx= Supercom 4400, Rx= Uniphone 1140)
- Testing only the down link, since it represents worst case
- Testing Nokia 6160 with dual mode: Analog and TDMA (IS-136)
- The sensitivity level is specified between -116 dBm and -113 dBm
- RSSI was changed from -50 dBm down to sensitivity levels
- No fading or network effects were added at this point
- FS/LS errors were counted as one error

TEST SET-UP


Oscilloscope
Transmitting
TTY
RJ11
FDM-2
adapter
CH1
CH2
Wavetek 3600D
Audio
IN
OUT
RF IN
RF cable
Receiving
TTY
RJ11
FDM-2
adapter
JBA4
test adapter

ANALOG TEST

- RSSI from -50 dBm down to -116 dBm
- Slow data entry (Manual)
- CER can be increased using two methods:
  - (1) Decrease frequency deviation (base station function)
  - (2) Decrease RSSI down to sensitivity levels
- As shown in results, a slight mismatch in peak deviation can adversely affect CER
- CER increases rapidly at and beyond sensitivity levels
- Increased CER is mainly due to expander high attack time
- The high attack time causes the receiver to completely miss the start bit, this effect is more profound near sensitivity levels

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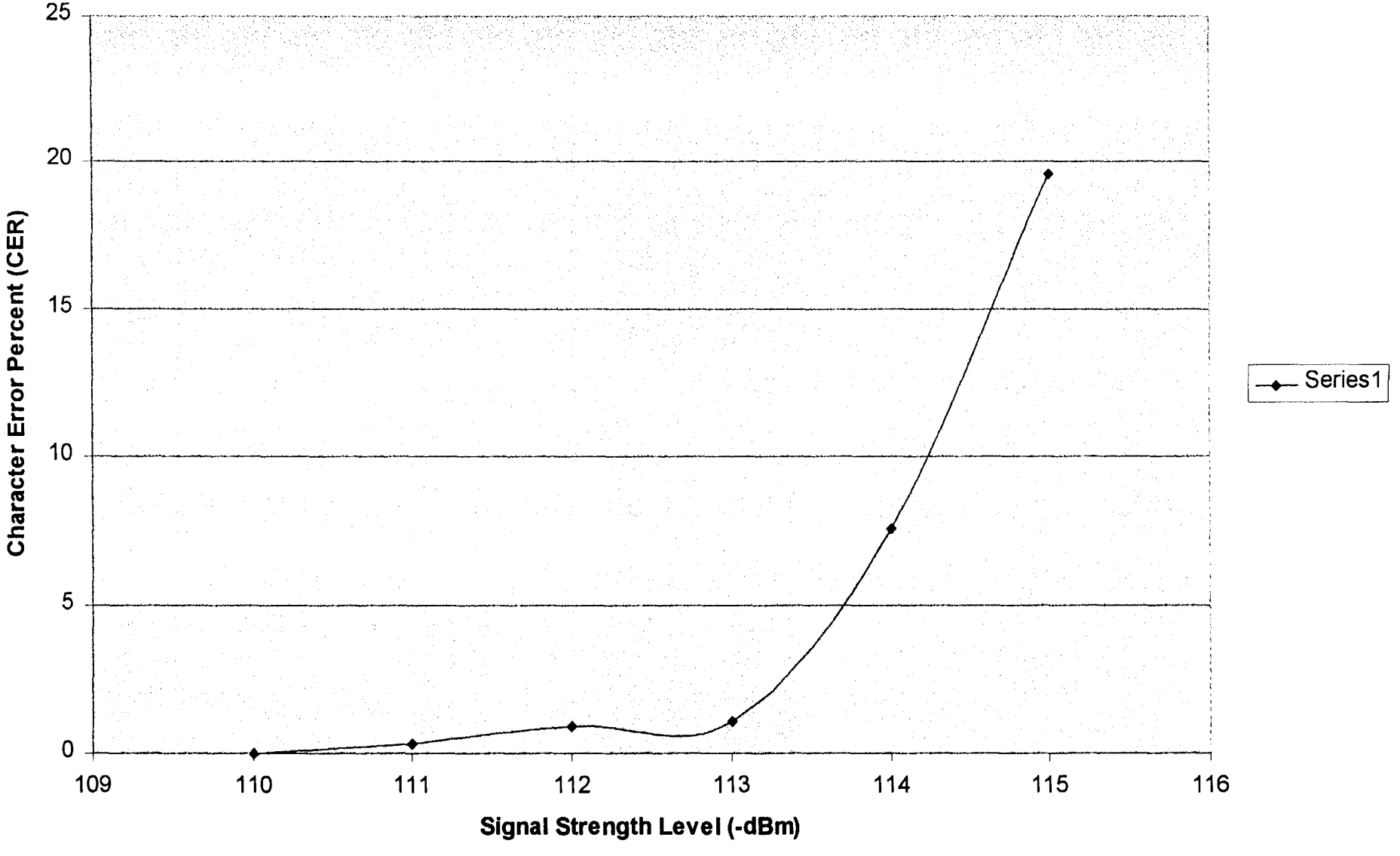
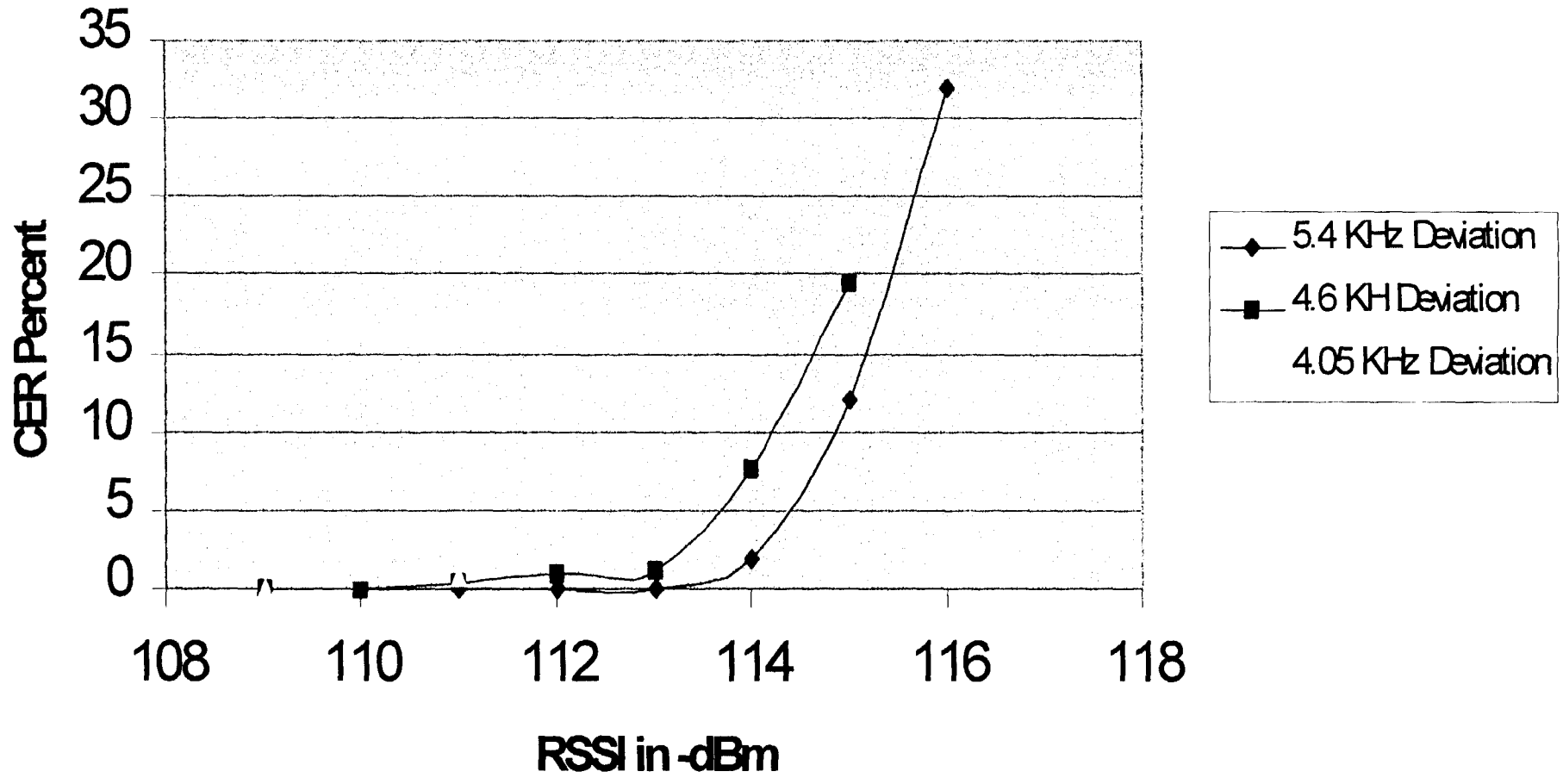
TTY With Analog Mode of Nokia 6160



TTY, CER vs RSSI for various Frequency Deviation



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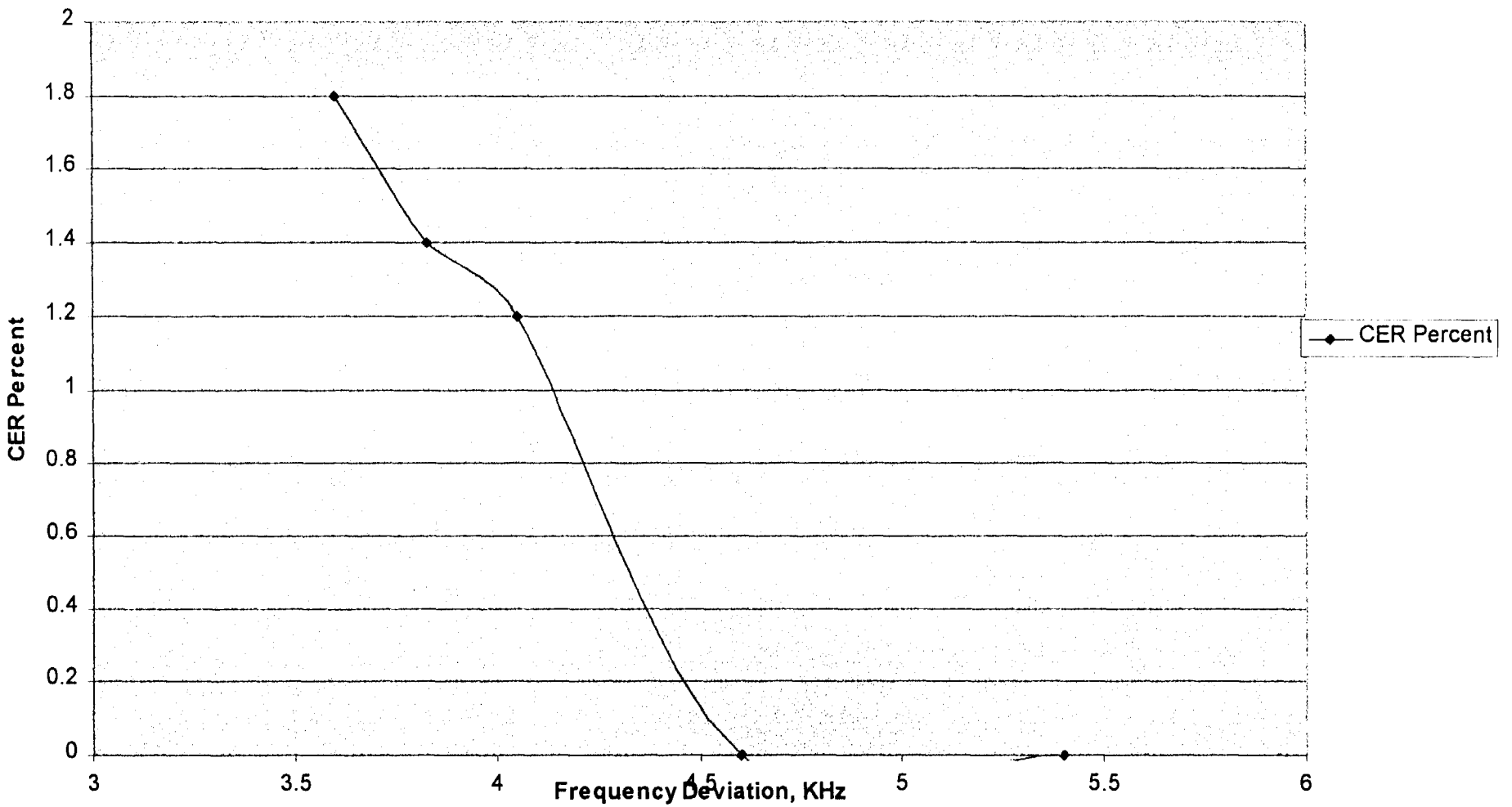
TTY, Analog Mode CER vs Freq. Dev. (RSSI = -110 dBm)



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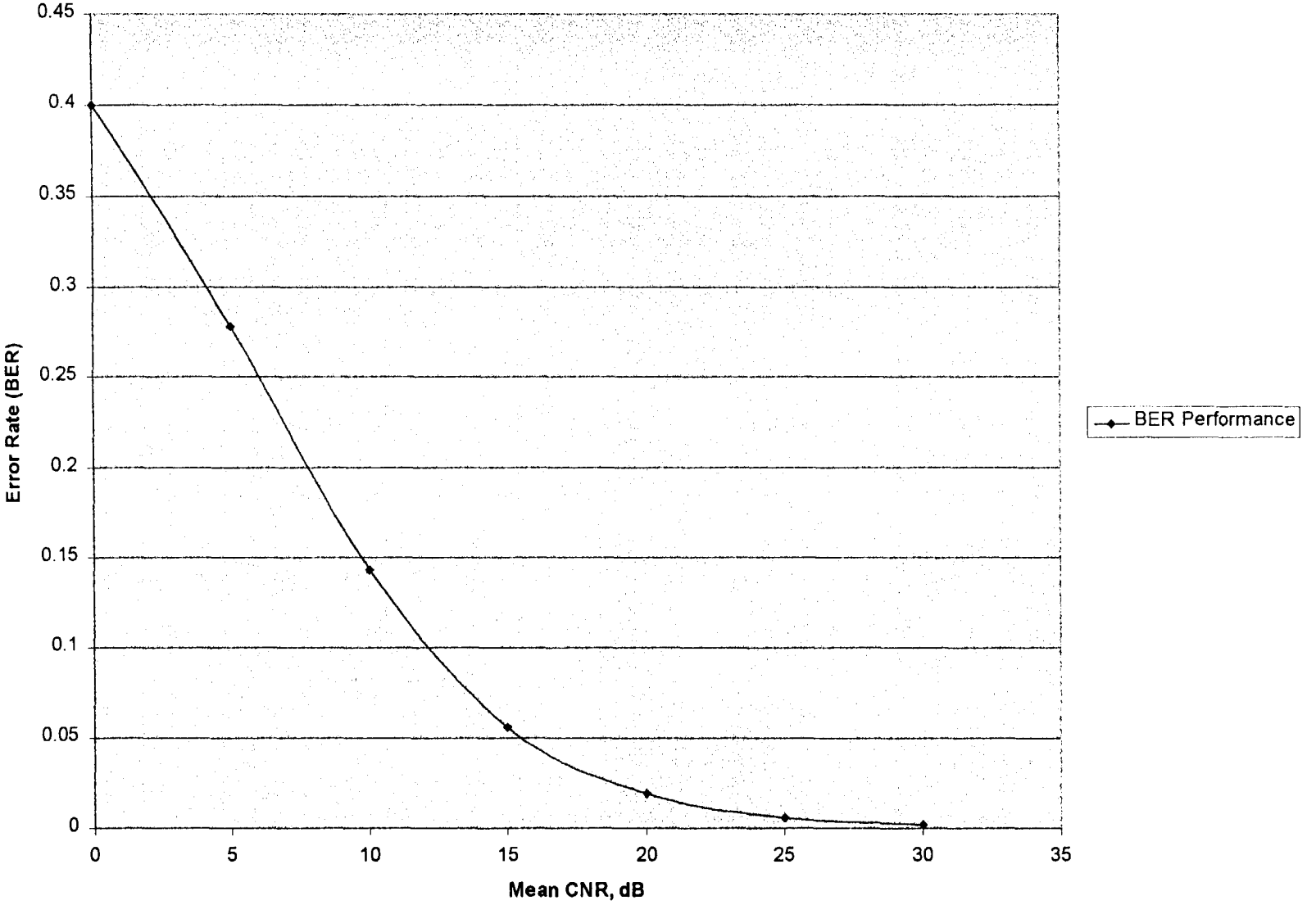
Analog Mode, Data BER Performance



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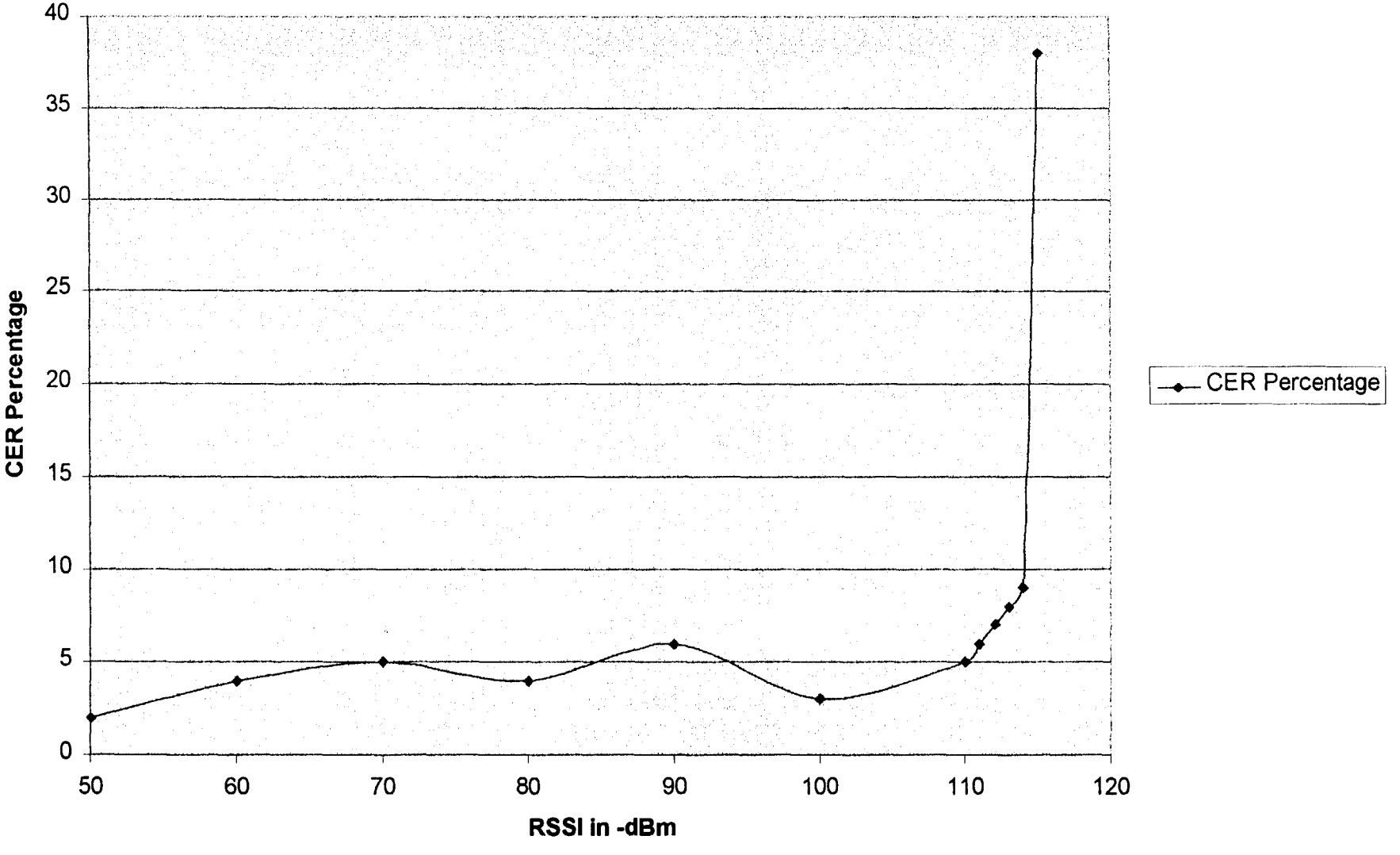
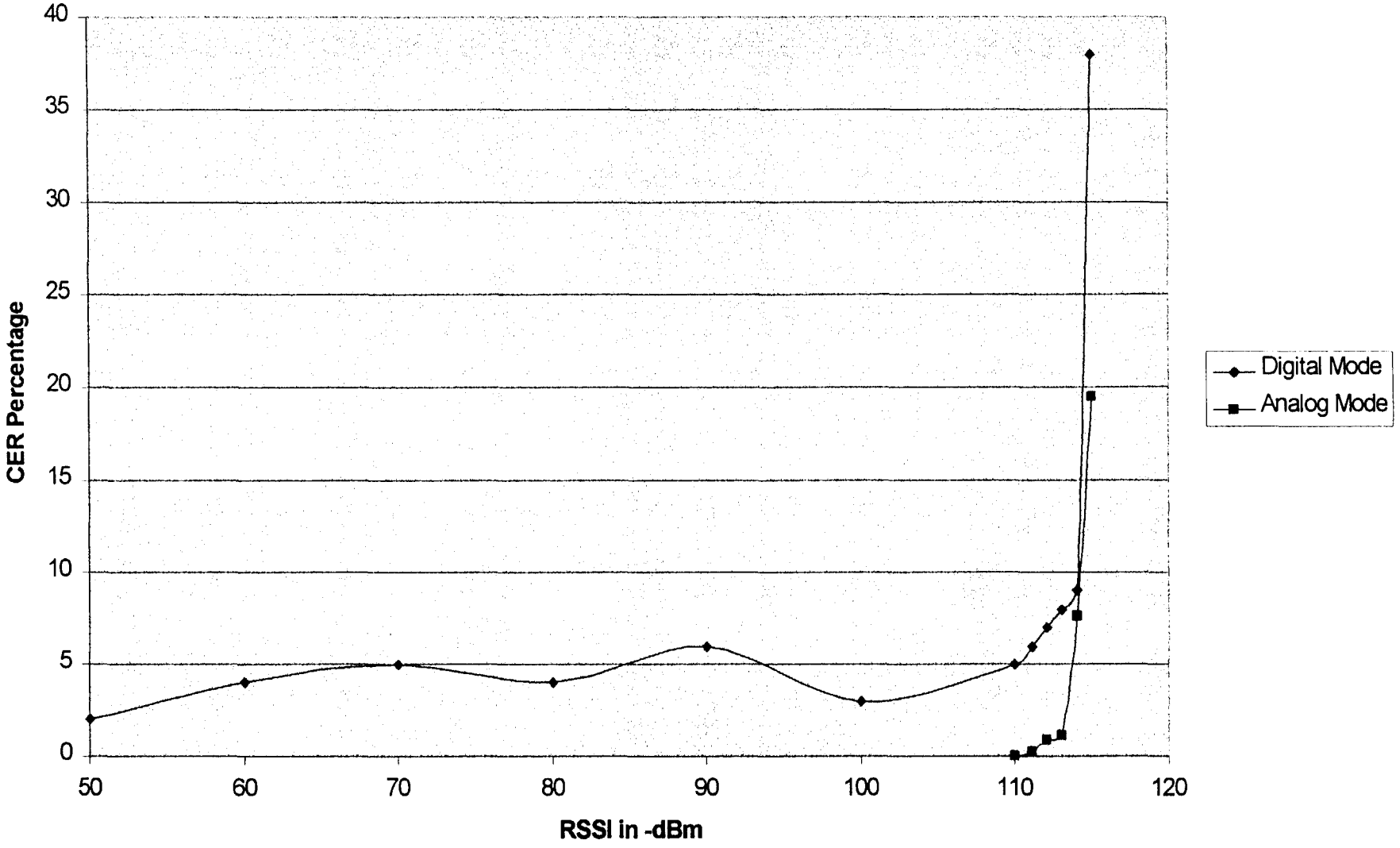
DIGITAL TEST

- RSSI from -50 dBm down to -115 dBm
- Slow data entry (manual)
- CER can be increased by decreasing RSSI down to sensitivity levels
- Residual CER is about 2% to 6% at high RSSI levels (It probably reflects the vocoder effects)
- For example, CER = 6% at RSSI = -90 dBm
- CER increases rapidly at and beyond sensitivity levels
- A large percentage of the errors are again due to missing the character start bit (is this due to vocoder attack time?)

TTY with Digital Mode (Nokia 6160)



TTY: Analog versus Digital Comparison



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WHAT IS NEXT

- Repeat these tests while counting FS/LS as N errors?
- Repeat for other technologies
- Repeat while introducing fading (multipath fading simulator)
- Repeat to isolate and test:
  - Hand over effects
  - Vocoder types
  - DTX
  - Frequency Hopping (for GSM)
  - Ciphering (for GSM)
  - Full/half rate effects
  - Network Effects
- Any others?

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